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Dwarfmistletoe of Lodgepole Pine

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Dwarfmistletoe (*Arceuthobium americanum* Nutt. ex Engelm.) causes heavy losses in lodgepole pine. Recent surveys in Colorado and Wyoming show that more than half the commercial type in those two States is infected to some degree. The surveys also indicate that in merchantable timber the parasite is responsible for about one-third reduction in growth and a marked increase in mortality. It is most damaging in partially cut stands and of least consequence on regenerated burns following holocaustic fires; damage in virgin stands is intermediate. The same is probably true for the lodgepole pine stands in Montana, Idaho, Utah, and other States that have not been surveyed.

Host Trees

The principal hosts of this parasite are lodgepole pine and jack pine. It is occasionally found on white spruce, knobcone pine, pinyon, limber pine, Jeffrey pine, and ponderosa pine. In the United States, damage of economic importance is confined to lodgepole pine, but in Canada the losses in jack pine are also significant. This parasite has not been found on the low-elevation form of lodgepole pine on the Pacific Coast. The low-elevation form, however, is sometimes attacked by another species (*Arceuthobium campylopodum* Engelm.), the principal dwarfmistletoe of ponderosa pine and associated host species there.

Appearance of Infected Stands

Recently infected stands show no abnormalities except the inconspicious dwarfmistletoe shoots on branches and main stems (fig. 1, *A*).

Where the parasite has been present for a long time, the stand will

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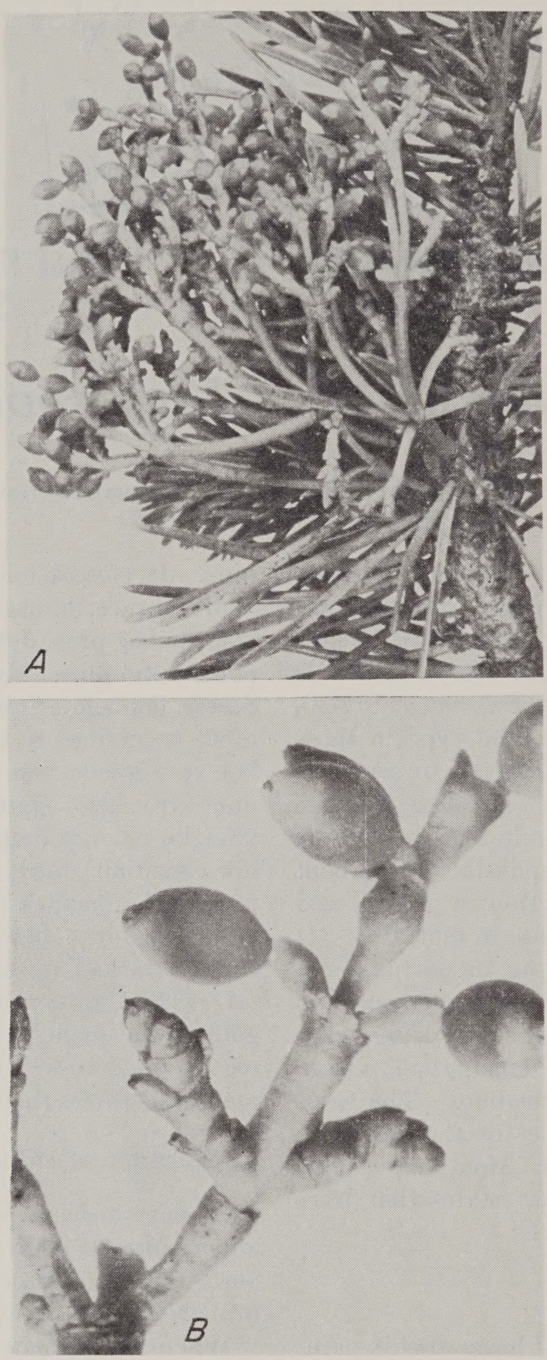

Figure 1.—Dwarfmistletoe on lodgepole pine. *A*, Aerial shoots on twig (about ⅔ natural size). *B*, Pistillate shoot, showing nearly mature, berrylike fruits above and flowers on the two basal side branches (about 3 times natural size).

Figure 2.—Damage center of a concentration of dwarfmistletoe in a virgin lodgepole pine stand. In the overstory, mortality is heavy, crowns are low in vigor, and witches'-brooms are common. In a situation like this, reproduction will be infected early and probably will die young.

have one or more heavily damaged centers, surrounded by increasingly healthier zones. The centers (fig. 2) are characterized by numerous trees exhibiting witches'-brooms (fig. 3, *A*) and spike tops, and by an abnormal number of snags bearing the remnants of witches'-brooms (fig. 3, *B*). Understory trees are likely to have an abundance of dwarfmistletoe shoots. The size of a center is primarily dependent on time and will vary from a fraction of an acre to 4 to 5 acres. Larger areas of heavy damage result when several centers merge.

Description of the Pest

Dwarfmistletoe is a parasitic seed plant. It produces delicate, olive-green, leafless, jointed shoots (fig. 1, *A* and *B*) on the stems and branches of the pine. The principal if not the only function of these shoots is reproduction. They bear the flowers and fruits but synthesize little, if any, carbohydrate foods. The great bulk of an established dwarfmistletoe plant is a network of absorbing strands that lie hidden in and gather nourishment from the bark and wood of the pine.

Figure 3.—*A*, Lower crown of lodgepole pine has large witches'-brooms caused by dwarfmistletoe; upper crown is thin because of scattered infection and because of starvation due to large witches'-brooms. *B*, Snag killed by dwarfmistletoe. Numerous witches'-brooms occur in the lower crown.

Seeds are borne singly in berry-like structures that are equipped with an explosive mechanism. At maturity, the elastic outer case of the berry, which is filled to capacity with water, breaks from its base, contracts violently, and flings the seed into the air with a force that carries it several feet. Flights up to 33 feet have been measured in the laboratory. The dispersal period is limited to a week or so in the fall. A sticky, hygroscopic substance (viscin) holds the seed fast to any surface on which it alights and also provides a moist medium for germination.

The seeds that settle on pine stems may germinate, send their absorbing strands into the bark, and start new plants. Several years must elapse before the first shoots are produced. The first fruits do not mature until about 16 months after flowers are pollinated. Only half of the dwarfmistletoe plants are capable of producing seeds; the others are staminate.

Ecology

A vigorous host favors the best development of dwarfmistletoe, much as good, rich, moist soil favors growth of a cabbage plant. The best trees of a stand, therefore, are likely to suffer the greatest damage from attack. Not only does the parasite prefer vigorous trees, but once established, it manages to continuously re-infect the more vigorous parts of those trees.

It re-infects by shooting the seeds upward into the growing top. Those that do not stick to the upper part of the tree continue their flight outward to infect surrounding trees within range. Those that alight on suppressed trees or branches may germinate but will not produce aggressive, long-lived dwarfmistletoe plants.

Effect on the Host

The ultimate effect of dwarfmistletoe is premature death of the host. The rate at which the parasite kills is largely dependent upon the age of the host at the time it is first attacked. Young trees tend to succumb quickly. Older ones with well-developed, vigorous crowns may show no appreciable ill effects from the parasite for years after the initial infection. As the parasite spreads through the crown, both by the extension of its absorbing strands in the bark and by re-infection from new seeds, growth of the tree is gradually retarded. Eventually the top weakens and dies, diameter growth virtually stops for several years, and death of the tree follows.

Besides retarding growth and causing death, dwarfmistletoe infection results in defect and degrade in the form of hypertrophies, pitch-soaked stem cankers, and excessively large knots. In some cases, trees are deformed beyond any commercial use.

Climate limits the abundance and frequency of this particular species of dwarfmistletoe. Throughout Colorado and Wyoming, its upper altitudinal limits coincide with the 30° F. mean annual isotherm, which

is 200 to 600 feet below the upper limits of commercial lodgepole pine.

Surveys indicate that the parasite shows a distinct preference for ridges and is scarce in bottoms. Microclimatic effects prevailing in these topographic situations appear to be responsible for the difference.

The parasite spreads more rapidly in open than in dense stands; similarly, it spreads faster in multistoried than in single-storied stands. The most rapid intensification and spread develops from an open overstory to a vigorous understory.

Fire plays a double role in the spread and intensification of dwarfmistletoe. Partial burns that leave an open, infected overstory create an ideal situation for heavy and rapid infection of the regenerated stand. Large complete burns, on the other hand, eliminate or so greatly reduce the parasite that it is of no further economic consequence. In such cases, invasion of the new stand takes place only from infected trees along the edges of the burn. Such an invasion is a slow process, particularly in dense, even-aged stands beyond the border about 20 feet wide that is bombarded with seeds from the infected overstory.

Intensification and spread depend primarily on the explosive force of the dwarfmistletoe fruits. However, occasional isolated infected spots suggest that the parasite may sometimes be carried long distances by birds or mammals.

Control

Partial cutting in dwarfmistletoe-infested stands creates ideal conditions for maximum damage. It should be avoided unless all infected overstory trees can be cut and the understory (1) is absent, (2) is free from infection at the time of cutting, or (3) can be made free of infection by stand improvement work following logging.

Clear cutting appears to be the best way to control dwarfmistletoe in lodgepole pine. However, unless all unmerchantable infected trees are cut or poisoned at the time of logging, the sanitation value of the operation will be lost. Any residual infected trees will send showers of seeds into the oncoming reproduction and lead to the development of damage centers in the next generation.

Even where stands are properly clear cut, some dwarfmistletoe will develop in the regenerated stands bordering infected areas in the residual strips or blocks. If, however, it is possible to cut the residual blocks within 20 or 30 years after the initial cut, damage to the residual stand will be relatively slight; if the dwarfmistletoe is cut out promptly after logging, damage will be practically nil.

For greatest benefits, units to be clear cut should have a low ratio of perimeter to area. This can be accomplished by making units large and compact, approaching a circle or square in shape. Narrow strips should be avoided. Too much of the cutover area will be within the in-

fection range from the uncut perimeter. Boundaries should not pass through infection centers if they can be avoided. For boundary location, bottoms should be favored over ridges.

Where dwarfmistletoe shoots develop on a branch more than a foot out from the main stem, removal of the branch will usually get rid of the parasite. Furthermore, by pruning large witches'-brooms, it is often possible to prolong the life and good vigor of the tree even though the absorbing strands may be in the trunk.

Because of the interval between seed germination and appearance of the first shoots, it is virtually impossible to see and destroy all dwarfmistletoe plants in one operation. The number and frequency of followup treatments in regenerated stands will depend on the intensity of infection in the residual stand, the length of exposure, and the degree to which it is necessary to reduce the parasite populations.

No effective chemical controls have been found. If they were available, it is doubtful that, for practical control, they could ever supplant silvicultural measures and proper management.

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